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Gen. Oleg. Kaza. مركز

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الجمعية السعودية لأمراض الطوارئ  
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## Clinical Management & Emergency Response to Blast Injuries: The Beirut Explosion

**Eveline Hitti, MD,MBA & Ziad Kazzi, MD**

No Conflicts of Interest to Disclose

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October 12-2020

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**AUB**  
1866  
American University of Beirut  
الجامعة الأمريكية في بيروت

**EMORY  
UNIVERSITY  
SCHOOL OF  
MEDICINE**

**Department of  
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- Beirut, Lebanon



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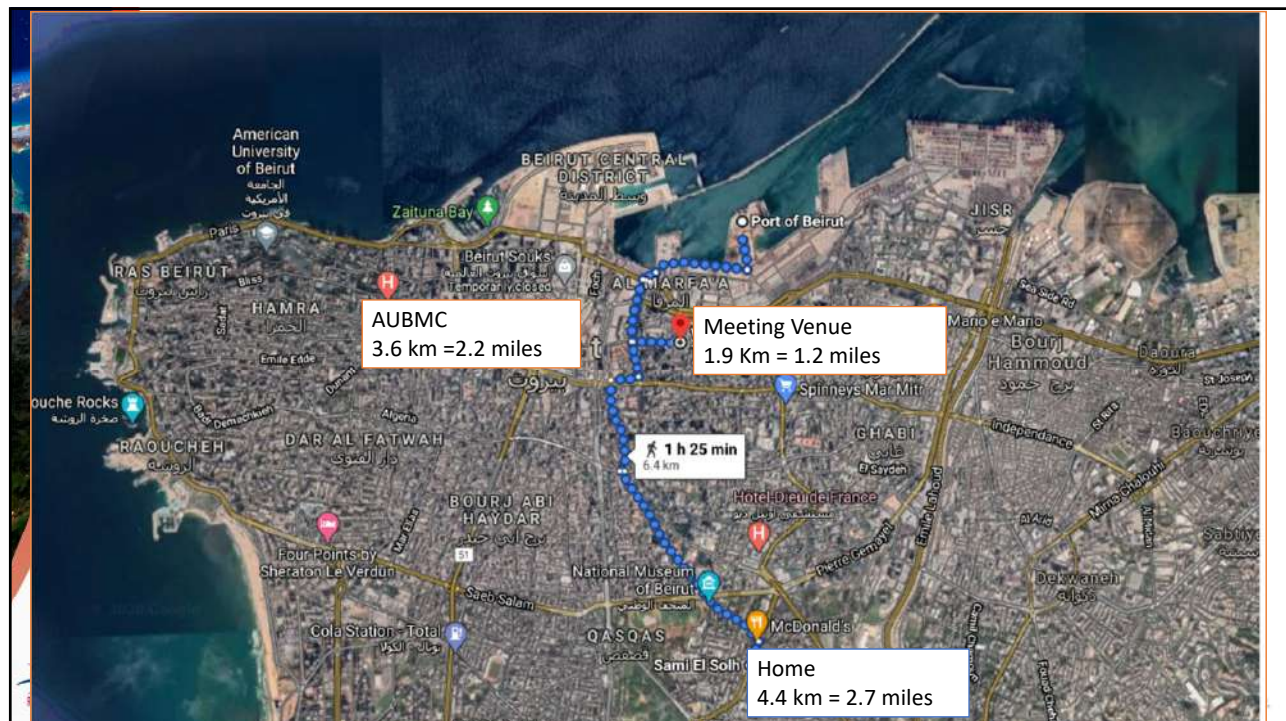
## Objectives

- Describe the events of the Beirut Explosion on August 4, 2020
- Describe the response of the American University of Beirut Emergency Department
- List 4 types of blast injuries
- Discuss the initial management of blast injuries
- Discuss the assessment of potential chemical or radiological hazards



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## Ammonium Nitrate Beirut port



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## Fire



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## Mushroom Cloud and Post-Blast Behavior



## Mushroom Cloud and Post-Blast Behavior



## BEIRUT EXPLOSION

**Chemical explosion rips through Lebanese capital which can be heard 110 miles away in Cyprus**

**Blast site**  
Total devastation

**1 mile**  
Partially collapsed buildings, people including kids injured

**2 miles**  
Homes damaged, windows blown out

**6 miles**  
Damaged buildings

International airport

Cyprus SYRIA LEBANON BEIRUT

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Logo of the Ministry of Health of Lebanon

Logo of the Ministry of Health of Lebanon

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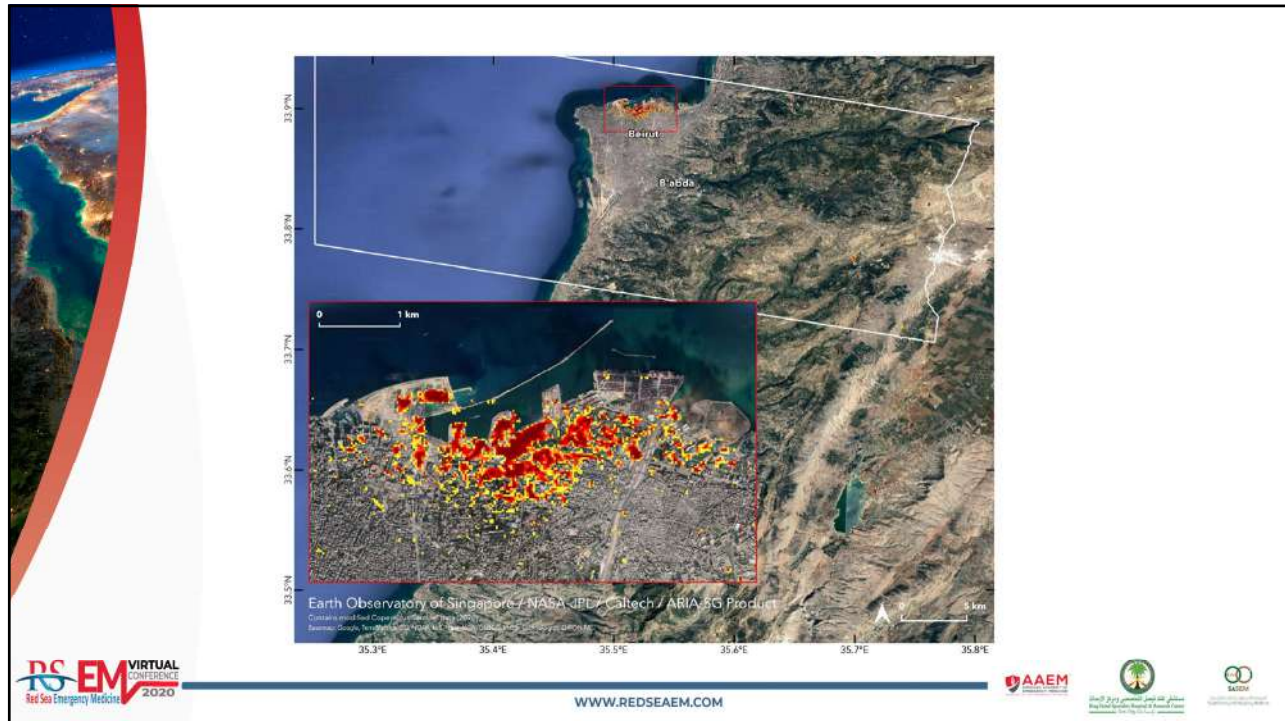
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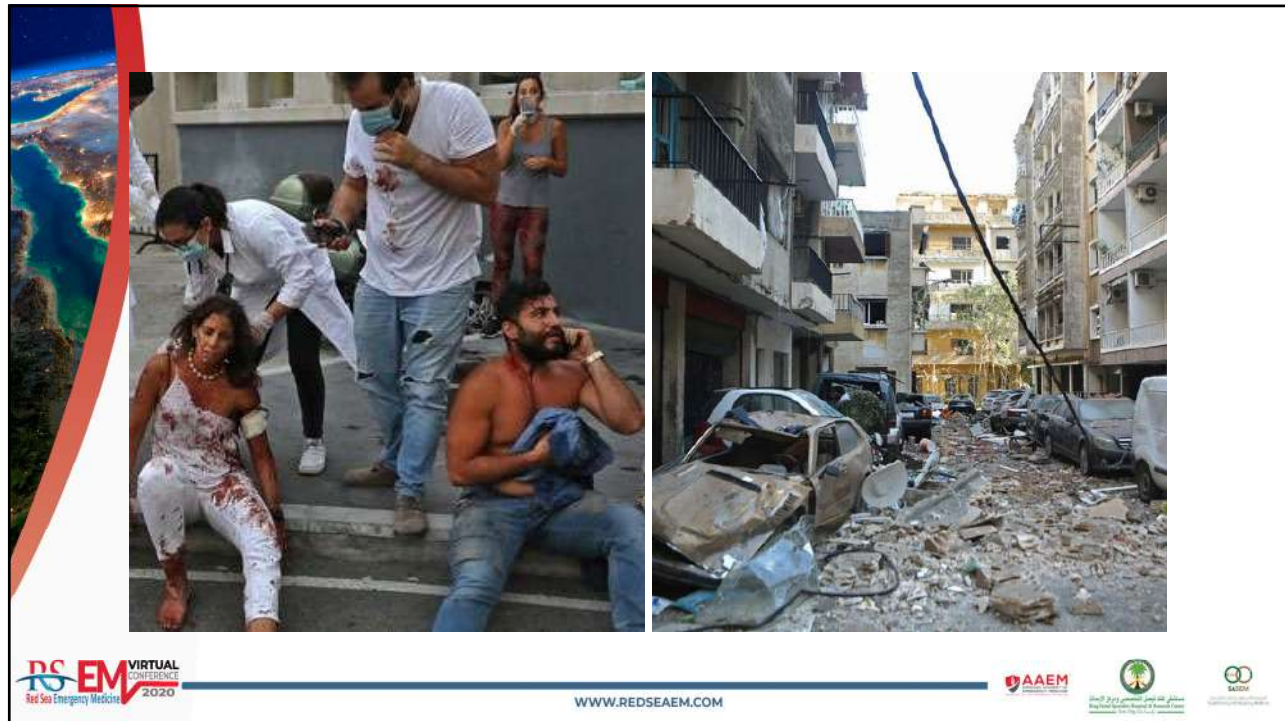
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Logo of the Ministry of Health of Lebanon

Logo of the Ministry of Health of Lebanon







## Access to Victims

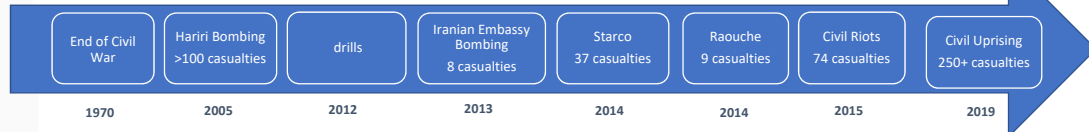




## AUBMC Response



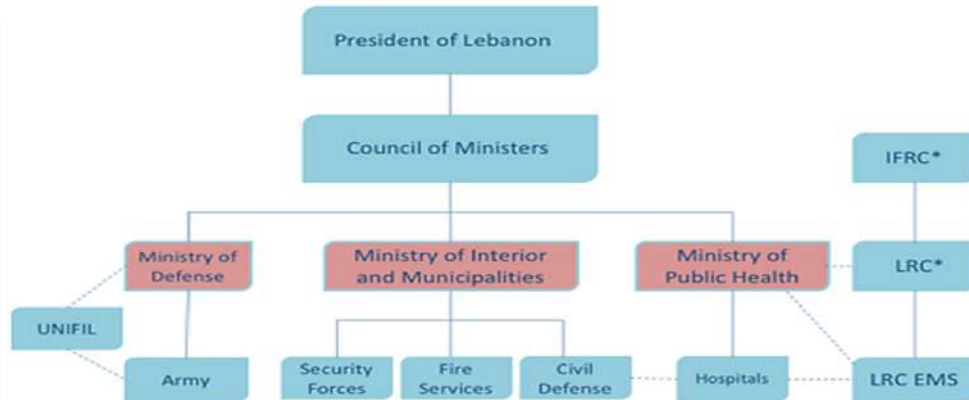
## EPP at AUBMC



2010-2013  
6 car bombs – Beirut and Tripoli  
94 killed and 860 injured

## Understanding the Preparedness Context

Current organization of Emergency and Disaster Response in Lebanon



\*International Federation of Red Cross and Red Crescent Societies  
\*Lebanese Red Cross

## Control in Chaos: Golden 15 min

### CONCEPTS IN DISASTER MEDICINE

Developing a Hospital Disaster Preparedness Plan for Mass Casualty Incidents: Lessons Learned From the Downtown Beirut Bombing

Mazen El Sayed, MD, MPH, FAAEM, FACEP; Ali F. Chami, MD; Eveline Hitti, MD, MBA

1. Activation
2. Security: crowd control
3. Triage
4. Patient Registration
5. Patient Tracking
6. Surge Capacity
7. Medication and Supplies
8. Communication

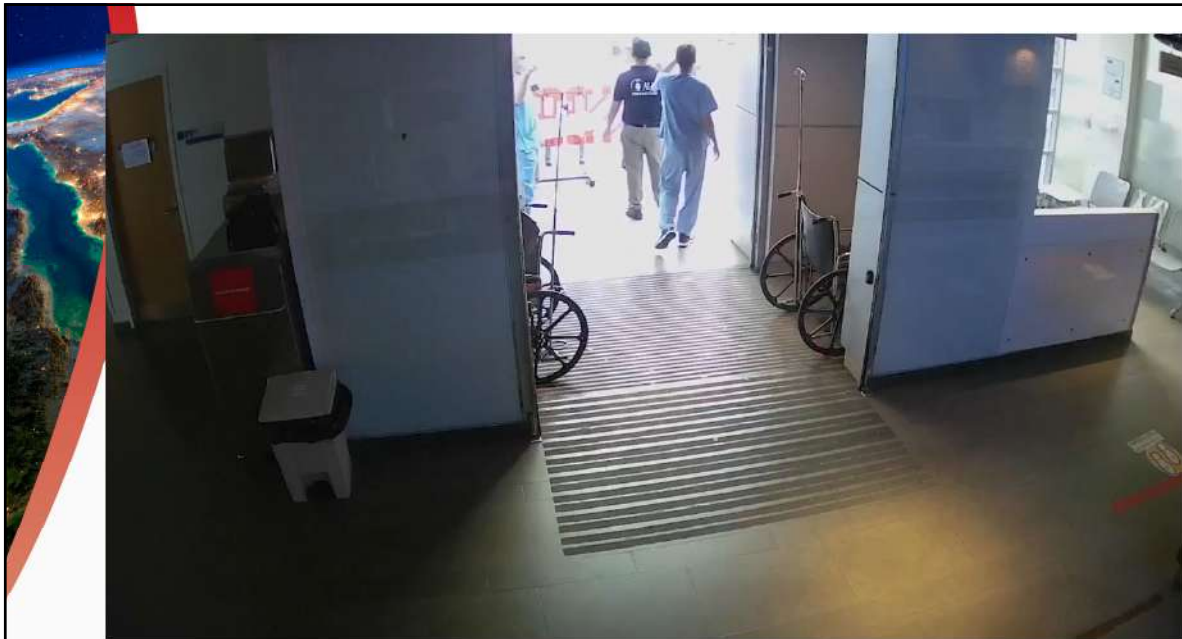
TABLE 1

#### Summary of Essential Actions Taken and Lessons Learned

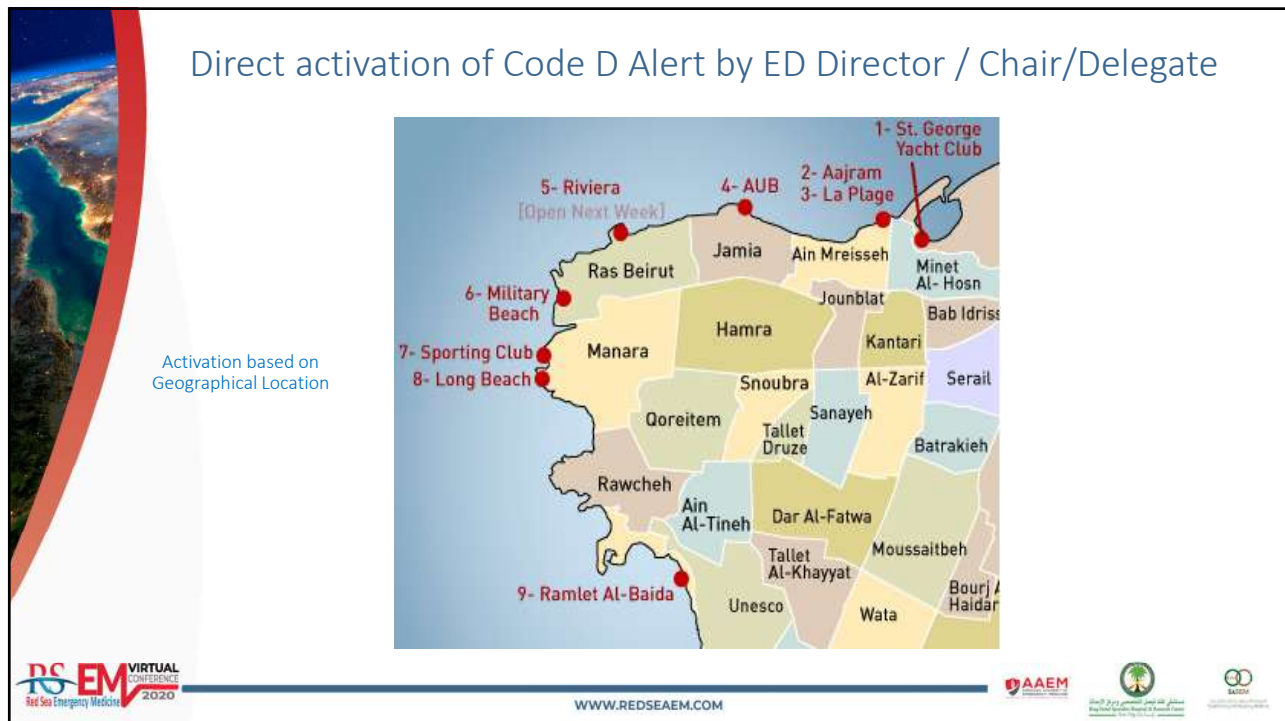
| Events and Challenges                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Lessons Learned                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Large influx of patients before plan activation</p> <p>Ambiguity in personnel roles</p> <p>Overcrowding of high-acuity areas with low-acuity patients when using the ESI scoring system for triage</p> <p>Inefficient patient registration</p> <p>Loss of coordination during patient movement from one area to another</p> <p>Inadequate relay of the disaster code to essential staff</p> <p>Delay in plan activation due to delay in information relay from the EMS agencies</p> <p>Inadequacy of purely paper-based information systems</p> <p>Delay in deployment of medical supplies</p> <p>Large influx of non-essential personnel to ED</p> <p>Demand from family members checking on condition of patients inside the ED</p> <p>Large patient surge to other hospital departments (blood bank, radiology, lab)</p> <p>Managing patient flow inside the ED</p> <p>Influx of large numbers of non-essential medical personnel</p> <p>Managing existing patients</p> <p>Assembly of media personnel at ED entrance</p> <p>Definitive patient registration numbers</p> <p>Resuming normal ED activity</p> | <p>Activation of a plan based on geographic proximity of the MCI</p> <p>Clearly define roles and responsibilities of ED physicians</p> <p>Prioritizing triage setup during plan activation, and switching to a standardized triage system</p> <p>Using unique identifiers numbers to identify patients</p> <p>Training staff on properly tracking patients using an existing electronic system</p> <p>Utilizing multiple methods of communication to essential staff during activation of the plan</p> <p>Ensuring adequate communication with EMS and news agencies</p> <p>Using an expansion of the existing IT system</p> <p>Deploying medical supplies upon the activation of the disaster plan and planning for ED shock</p> <p>Complete lockdown of hospital access points</p> <p>Designating an area next to the ED entrance for handling enquiries about patient status</p> <p>Close coordination between the ED and rest of the hospital departments</p> <p>Allow only the upgrading of patients to higher-acuity areas</p> <p>Tracking with casualty identifiers within the ED (manually or through a scanning system)</p> <p>Secure all doors, allowing only authorized essential staff to access the ED</p> <p>Decongesting ED upon activation of plan</p> <p>Designating an area outside the ED designated for the media</p> <p>Coupling of MCI numbers to patients' actual hospital registration numbers during the recovery phase</p> <p>Debriefing, cleanup, waste disposal, and resupply of medical equipment during the recovery phase</p> |

## Scale of Response

- 360 casualties first night, 800 by 1 week
- 87 admissions
  - 16 OR
  - 19 Critical
  - 52 Regular
- 12 Deaths





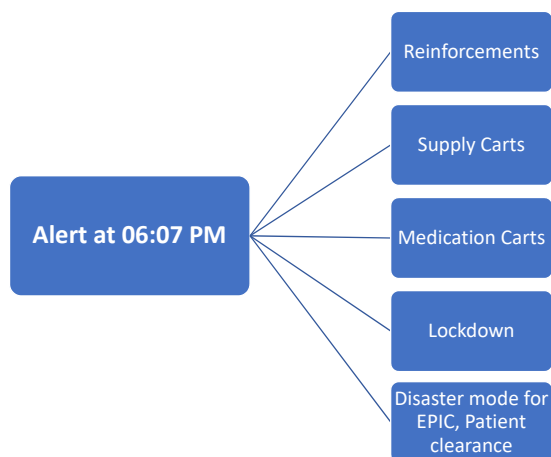


## Alert Communication

- Disaster lists for each activation level



## Alert Downstream Activations



## ED Crowd Control

- Lockdown



## Surge Areas





## Challenges: Patient Registration

- 200 MCR pre-pared in EPIC EMR
- Down-time Process

- Staff dismissal impact



## Downstream Impact

- Patient Tracking
- Human Record Keepers



© Eveline Hitti 2020



## Downstream Impact: Admission

- 87 Admissions in 40 bed ED
- Gridlock
- Cleared by 1am

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## Downstream Impact: Identifying Victims



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## Other Lessons

## Crisis Standards of Care



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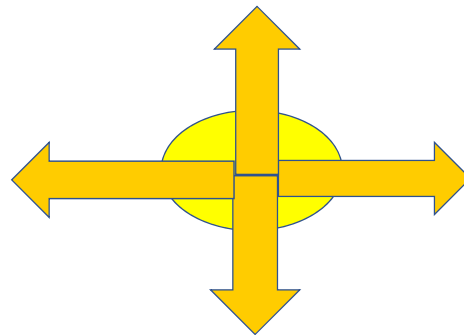






## Definition of Blast Injuries

- High-order
  - Primary blast wave
  - Detonate
  - Dynamite, TNT, Ammonium Nitrate Fuel Oil, C4
- Low-order
  - No blast wave
  - Deflagrate
  - Gasoline, gun powder



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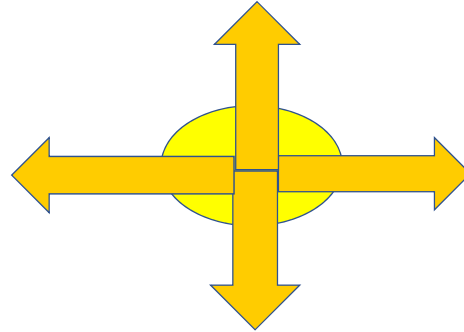
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## Definition of Blast Injuries

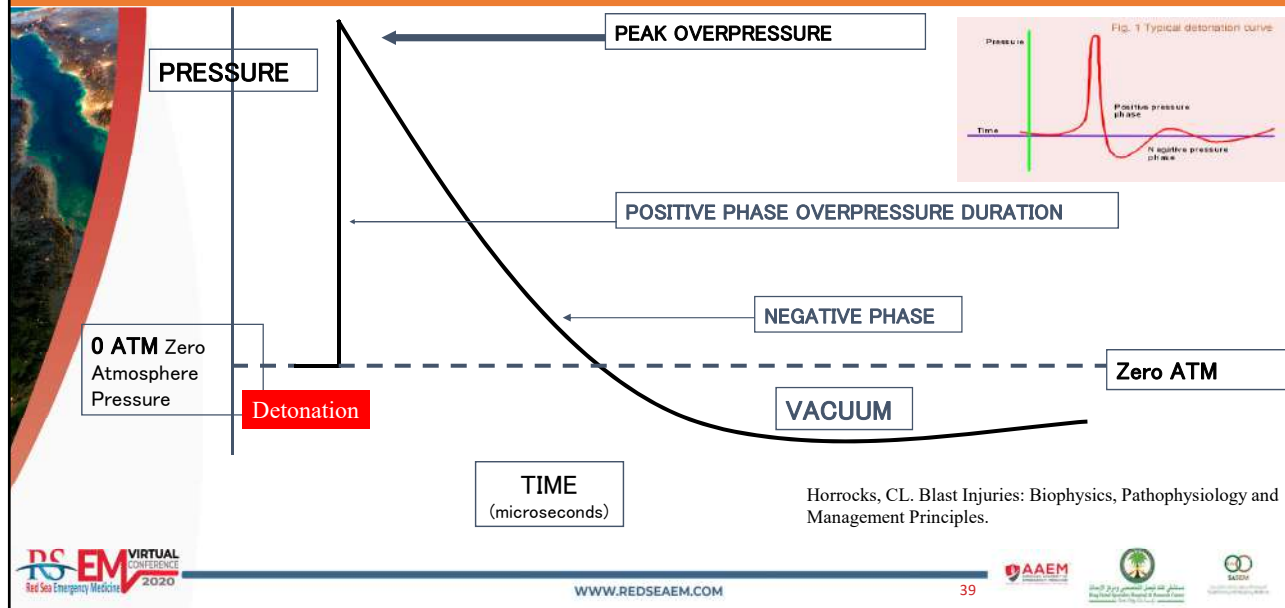
- Injuries sustained during or after the explosion
- The explosive material release a wave of pressure and heat
  - Fragments from device are also ejected and cause injuries



## Types of Explosives

- High-order
  - Primary blast wave
  - Detonate
  - Dynamite, TNT, Ammonium Nitrate Fuel Oil, C4
- Low-order
  - No blast wave
  - Deflagrate
  - Gasoline, gun powder

## Idealized Primary Blast Overpressure Waveform



## Blast Injuries

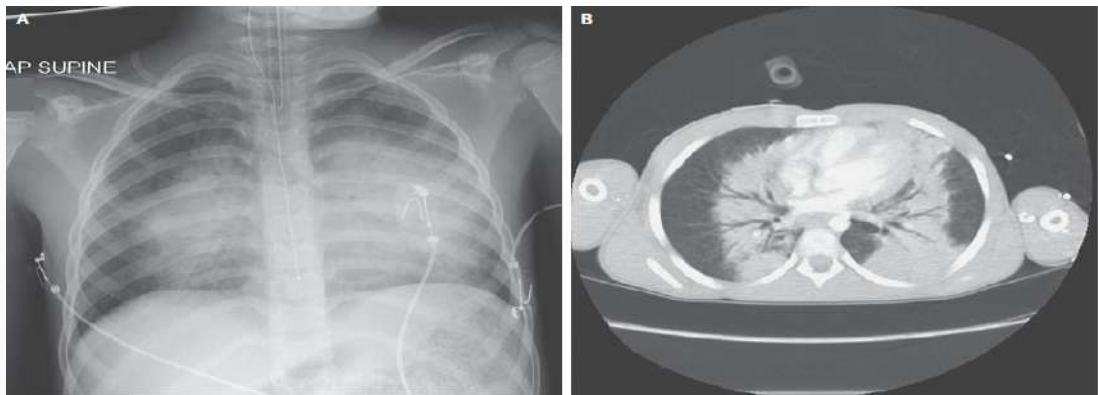




## Primary Blast Injuries

- Tympanic membrane rupture
  - Can be bilateral
  - Tinnitus, hearing loss, vertigo, vomiting
- Blast lung
  - Chest pain, cough, shortness of breath. Early onset
  - CXR "Butterfly Infiltrates"

## Blast Lung



N ENGL J MED 368;11 NEJM.ORG MARCH 14, 2013

## Primary Blast Injuries

- Visceral injury
  - Early
  - Delayed
- Other:
  - Globe rupture
  - Head injury

## Secondary Blast Injuries

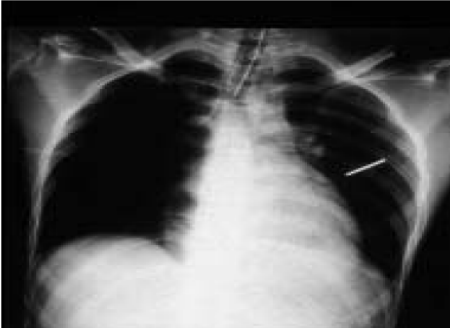
- Penetrating injuries from:
  - Primary fragments (fragments that are part of the weapon)
  - Secondary fragments (those that result from the explosion)





Prehospital and Disaster Medicine © 2003 Asa

**Figure 1**—Photograph of the patient's abdomen showing a small subxiphoid entry wound



Prehospital and Disaster Medicine © 2003 Asa

**Figure 2**—Chest radiograph showing a nail embedded in the patient's left lung



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## Tourniquets

- Better when applied in the prehospital phase and before shock
- Low morbidity
- Decreased mortality from external exsanguination of a single limb

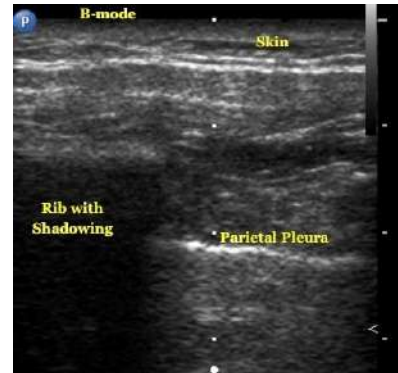


## Two life-saving interventions

- Airway
- Chest tube or needle thoracostomy

## Tertiary Blast Injuries

- Blunt trauma
- Head injury
- Extremity fractures
- Pelvic fractures
- Spine injuries
- Crush injuries



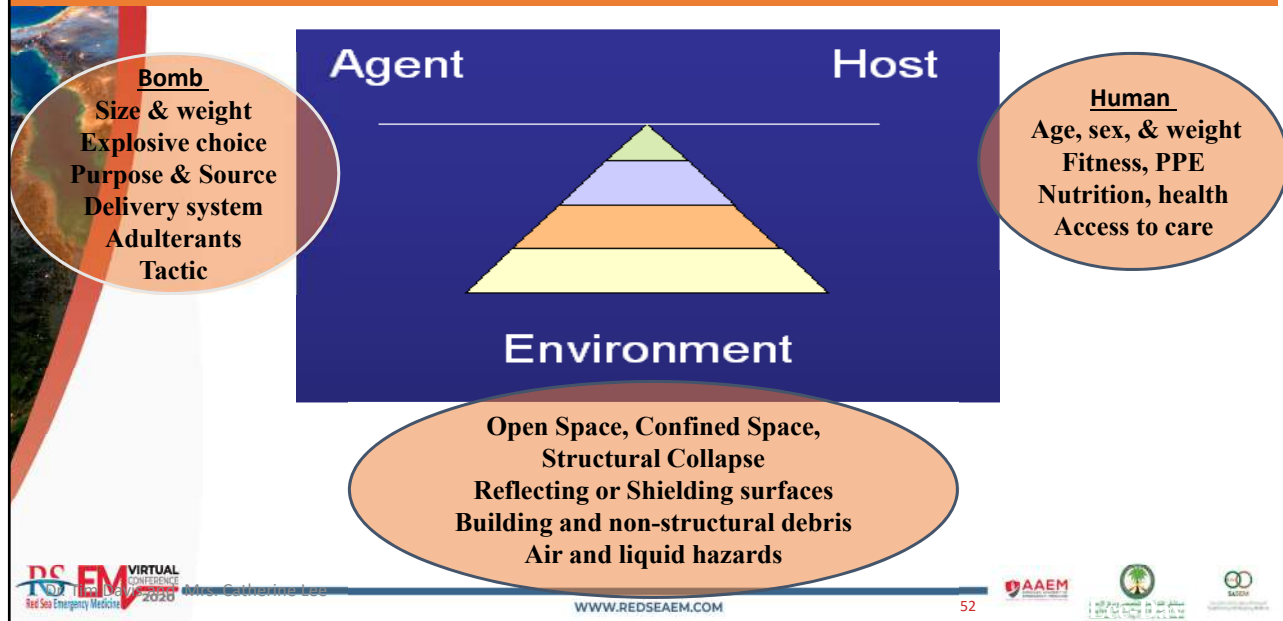
## Crush Syndrome

- Elevated CK and myoglobin
- Renal failure
- Management:
  - IVF
  - Not widely adopted: IV Sodium bicarbonate and IV mannitol
  - Hemodialysis for renal failure

## Quaternary Blast Injuries

- Smoke inhalation and burns
- Contamination with chemical, radiological, or biological device components
- Exacerbation of pre-existing illnesses and health conditions (e.g, asthma, heart disease, mental illness)

## Bomb-Injury Threat Model







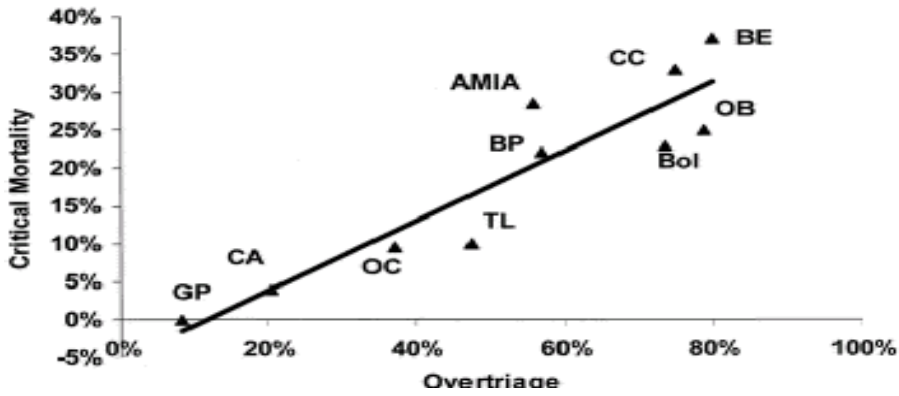
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https://www.redseaem.com/enrichaoui/status/1295595705482704896?s=21

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## Overtriage and Critical Mortality



| Disaster Code | Overtriage (%) | Critical Mortality (%) |
|---------------|----------------|------------------------|
| GP            | ~10            | ~2                     |
| CA            | ~20            | ~5                     |
| OC            | ~35            | ~8                     |
| TL            | ~45            | ~10                    |
| BP            | ~55            | ~22                    |
| AMIA          | ~55            | ~28                    |
| CC            | ~70            | ~32                    |
| Bol           | ~75            | ~22                    |
| OB            | ~80            | ~25                    |
| BE            | ~85            | ~35                    |

Frykberg, ER, Medical Management of Disasters and Mass Casualties From Terrorist Bombings: How Can We Cope? J Trauma. 2002;53:201-212.

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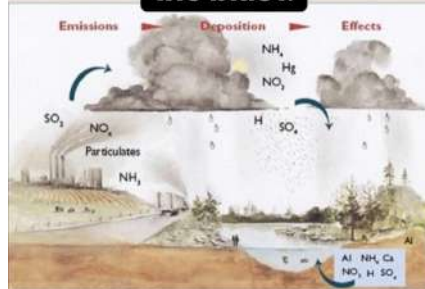
## Public Health Aspects

- Chemical concerns
- Ionizing radiation
- Environmental health
- After-event monitoring

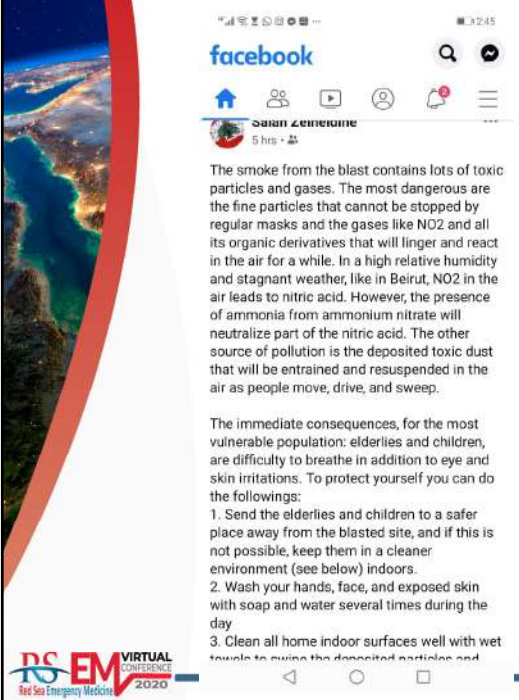


3 at least 154 people. Pics: Talal Traboulsi/Reuters/Tri/AFIP/Getty

**The rain is a  
result of the  
emissions from  
the blast.**



**Try not to get  
exposed**



The smoke from the blast contains lots of toxic particles and gases. The most dangerous are the fine particles that cannot be stopped by regular masks and the gases like NO<sub>2</sub> and all its organic derivatives that will linger and react in the air for a while. In a high relative humidity and stagnant weather, like in Beirut, NO<sub>2</sub> in the air leads to nitric acid. However, the presence of ammonia from ammonium nitrate will neutralize part of the nitric acid. The other source of pollution is the deposited toxic dust that will be entrained and resuspended in the air as people move, drive, and sweep.

The immediate consequences, for the most vulnerable population: elderly and children, are difficulty to breathe in addition to eye and skin irritations. To protect yourself you can do the followings:

1. Send the elderly and children to a safer place away from the blasted site, and if this is not possible, keep them in a cleaner environment (see below) indoors.
2. Wash your hands, face, and exposed skin with soap and water several times during the day
3. Clean all home indoor surfaces well with wet towels to remove the deposited particles and



Airborne particle measurements taken near the World Trade Center in Manhattan in 2001 demonstrated an elevation of PM<sub>2.5</sub> for weeks following the collapse, with ongoing intermittent releases of dust and smoke at the site during debris removal. It is likely that the dust coupled with the glass fibers present was responsible for observed inflammation in the upper respiratory systems.

<https://link.springer.com/article/10.1007%2Fs10694-012-0284-7>

أظهرت قياسات الجسيمات المحمولة جوا التي تم إجراؤها بالقرب من مركز التجارة العالمي في مانهاتن في عام 2001 ارتفاع PM<sub>2.5</sub> لأسابيع بعد الانهيار ، مع استمرار إطلاق منقطع للغيار والدخان في الموقع أثناء إزالة الحطام. من المحتمل أن الغبار المقذوف بالآلاف الإرجحية الموجودة كان مسؤولاً عن الالتهاب الملحوظ في الجهاز التنفسي العلوي.

It is advised that people wear masks at all times when outdoors

LINK.SPRINGER.COM  
**Health Effects of the World Trade Center 9/11 Disaster: An Overview**



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## Red Brown Smoke





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## Radiation Background Byblos



## Radiation Background Unknown Location

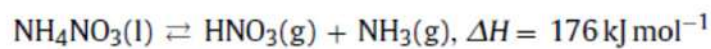




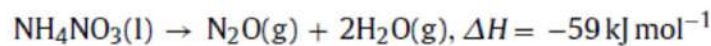
## Plume Next Day Over Bekaa Valley



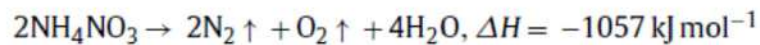
## Medical Toxicology Assessment: Decomposition of Ammonium Nitrate Depends on Conditions of Chemical Reaction



At higher temperatures (*i.e.*, 170–280 °C), an exothermic irreversible reaction occurs and AN decomposes into water and nitrous oxide.



If AN is suddenly heated up to a relatively high temperature, explosive decomposition will occur, producing nitrogen, oxygen, and water [10,16].





## Firefighters and PPE Toxidrome recognition



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## Firefighters and PPE Toxidrome recognition



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To Our Precious Victims:  
We Will Rise Again!





Hope we can host you soon in Lebanon!



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